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Dynamics of greenhouse gases in the river-groundwater interface: A case study of a gaining stretch of the Triffoy river (Belgium).

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The aims of this work are to investigate the occurrence of greenhouse gases (GHGs) and assess the role of groundwater as an indirect pathway of GHG emissions into surface waters in a gaining stretch of the Triffoy river agricultural catchment (Belgium). To this end, nitrous oxide (N_2O), methane (CH_4) and carbon dioxide (CO_2) concentrations, the stable isotopes of nitrate (NO_3^-) and major and minor ions were monitored in river water and groundwater during 8 months. Results indicated that groundwater is strongly oversaturated in N_2O and CO_2 with respect to atmospheric equilibrium (50.1$\pm$16.7 μg/L vs. 0.55 μg/L for N_2O and 14,569$\pm$3843 ppm vs. 400 ppm for CO_2), but only marginally for CH_4(0.45$\pm$0.89 μg/L vs. 0.056 μg/L), suggesting that groundwater can be an emission source of these GHGs to the atmosphere. Nitrification seems to be the main process for the accumulation of N_2O in groundwater (absence of ammonium, presence of nitrate and oxic groundwater). Oxic conditions prevailing in the aquifer are not prone to the CH_4 generation. In fact, the emissions of CH_4 to the atmosphere are one to two orders of magnitude higher than the inputs from groundwater, meaning that CH_4 emissions from the river to the atmosphere are nearly exclusively due to CH_4 in-situ production in river-bed or riparian zone sediments. For CO_2 and N_2O, average emissions from groundwater are 1.4×10^5kg $CO_2 Ha^{-1}y^{-1}$ and 190.5kg N_2O $Ha^{-1}y^{-1}$, respectively. Groundwater is probably an important source of N_2O and CO_2 in gaining streams but when the measures are scaled at catchment scale, these fluxes are probably relatively modest. Nevertheless, their quantification would better constrain nitrogen and carbon budgets in natural systems.